

SPIROCHETES IN THE CAT WITH SPECIAL REFERENCE TO
THOSE OF THE ALIMENTARY TRACT

By ELOISE E. GREENE

Submitted to the Board of University Studies
of the Johns Hopkins University
in conformity with the requirements
for the degree of doctor of philosophy
January 1, 1932

REPRINTED FROM THE JOURNAL OF THE
ELISHA MITCHELL SCIENTIFIC SOCIETY
Vol. 49, No. 2, April, 1934





Digitized by the Internet Archive
in 2026

SPIROCHETES IN THE CAT WITH SPECIAL REFERENCE TO THOSE OF THE ALIMENTARY TRACT¹

By ELOISE E. GREENE

PLATES 21 AND 22

INTRODUCTION

The purpose of this paper is to review the types of spirochetes in normal cats, as they are found in the alimentary tract, especially in the mouth, caecum, and large intestine, through study of the fresh material under the dark-field and through the study of fixed stained specimens. A survey of the principal organs including the heart, lungs, liver, spleen, and kidney, is included. The filtration and cultivation of the spirochetes and their implantation in young cats are also dealt with.

Summarizing the historical data, it will be noted that most of the work done on the spirochetes of the cat has involved those of the stomach. Salomon's (16) work deals with the three gastric types. Though Escherich (5) mentioned the fact that spirochetes were found in the caecum and large intestine, he described only a coarse corkscrew form. MacFie (10) noted a type found in the large intestine and rectum which was very loosely coiled. Sanarelli (17) observed that spirochetes lived especially in the large intestine. DeMello and Fialho (4) noted and illustrated only one type similar to the *Spirochaeta eurygyrata*, the human intestinal spirochete. Nowhere in the literature is there a complete survey of the spirochetes of the cat. Only the spiral forms found in the stomach and one type found in the large intestine are described. No reference to the types of spirochetes in the mouth was found.

EXPERIMENTAL WORK

The study of spirochetes in the cat was divided into the three following divisions: 1. Study of the living material under the dark-field, and observation and measurement of fixed stained specimens. 2. Filtra-

¹ From the Department of Bacteriology, School of Hygiene and Public Health, The Johns Hopkins University, Baltimore. The writer wishes to acknowledge the assistance given by Dr. W. W. Ford and Dr. L. B. Lange in this investigation.

tion and cultivation experiments. 3. Implantation experiments in young cats *per os* and *per rectum*. All work was done on apparently healthy cats secured from various sources. Most of the animals were killed immediately, but a few were kept from 2 days to a week in the laboratory until needed. The animals were not fed for approximately 15 hours preceding the examination.

1. Study of living material under the dark-field and observation and measurement of fixed stained specimens

The animals were killed in the laboratory either by ether or gas and the entire alimentary tract removed. The oesophagus, stomach, caecum, and large intestine were each removed with uncontaminated instruments and placed in separate Petri dishes. The small intestine was roughly divided into duodenum, jejunum, and ileum and the three parts placed in separate Petri dishes. The oesophagus, stomach, and intestines were each opened with a pair of sterile scissors and the contents washed out with physiological salt solution. Studies were made under the dark-field of the contents, and of the mucosal scrapings emulsified in Ringer's solution.

A. Living material

Under the dark-field four distinct types of spirochetes, the spironeme, treponeme, fusi-spiral, and leptospira, were found in the living material.

Adult cats. Forty-eight out of fifty adult cats contain spirochetes in the mouth or gastro-intestinal tracts or both. Spironemes, treponemes, fusi-spirals, and in a few cases leptospiras were observed in the mouth, caecum, and large intestine, the spironemes and treponemes usually in large numbers. Fusi-spirals were scarce in the mouth, but abundant in the caecum and large intestine, especially in the caecal scrapings. Leptospiras were never numerous.

a. Mouth: The organisms differed in size and proportions but four common types stood out. The most common was a spironeme (No. 1), approximately 10μ long and 0.5μ thick when stained with the Klieve and Klieve-Harris stains. It is usually extremely flexible, the spirals in many cases undergoing frequent change. Some individuals of this type were quite sluggish, sometimes remaining motionless for short periods before resuming their characteristic movement. There are 3 to 6 rather shallow, irregular curves and the ends are sharply tapered (Figs. 1 and 2). In quiescent forms the spirals were more regular. This spirochete was classified in the present summary as a spironeme,

because of its great flexibility and the frequent change in the form of the spirals, relatively shallow and few in number, together with a greater bending and lashing than is seen in the typical treponeme. Though most of the spironemes were from 10μ to 15μ long, many were 20μ to 30μ and some even longer (Figs. 2 and 3). These were evidently in the stage preceding division as shown in Fig. 2. Their thickness was usually 0.5μ .

A second spironeme (No. 2) often observed in the mouth appeared under the dark-field as a long thick organism with a definite double contour and wide, flat curves. It is from 10μ to 30μ long and 0.75μ to 1μ thick (Fig. 2). A similar organism, obtained from the human mouth, was described by Noguchi (15).

A third spironeme (No. 3) is that shown in Fig 4b. This organism was present in the mouth of eleven cats, in the caecal scrapings of two cats, and in the colonic scrapings of one cat. This organism is approximately 20μ to 25μ in length and has small, regular, primary spirals and usually two secondary curves of 5 to 6 primary spirals each. The latter remain practically fixed, but there appears to be a continuous change in the primary spirals. The rotation of the body with the resulting progression of the light reflex gives the impression of a wave-like motion along the length of the organism. When stained, both the secondary and primary spirals usually become irregular (Figs. 3 and 4). The ends are pointed. It resembles the *Spirochaeta pseudorecurrentis* of Zuelzer (21), a water spirochete probably with a number of subspecies (Fig. 4a).

A fourth spironeme (No. 4) was noted in fresh material from the mouths of 11 cats. It also occurred in the ileal contents of a kitten about 10 weeks old, and in the contents and scrapings of the caecum of an adult cat, where it was clearly observed under the dark-field, and in fixed, stained specimens among the more common spironemes mentioned above. It is a typical spironeme approximately 10μ long and 0.3μ to 0.5μ thick, with 3 to 6 spirals which are fairly constant when the organism is in motion and maintain their form in fixed preparations (Fig. 5). The spiral depth and amplitude is 2μ . The ends are pointed but no terminal filaments were seen. A small projection appears at the apex of each rounded spiral, clearly visible under the dark-field and in the films stained by the Kliewe-Harris method. The regularity of these projections and their constancy despite rotation of the spirochete suggest that they may represent a thin lateral extension of the body, or a regular series of protrusions too small to distinguish individually, arising

from the convex surface of the spirals along the length of the organism. Such a continuous or intermittent ridge might account for the microscopic picture. One would expect such a ridge to be seen clearly where it would protrude from the apices of the spirals into a vacant background, but to be seen less clearly if at all, between the apices where, as viewed by the observer, it would lie above or below the body of the spirochete. While the projections from the apices of the spirals appear in stained specimens as they do under dark-field illumination, it has not proved possible up to the present to demonstrate a hypothetical ridge along the body between the spiral apices by any of the staining methods used in this work. A thorough search of the available literature has not disclosed a record of this morphological type. The name *Spironema langei* n. sp., is suggested for this spirochete.

The small lateral protrusions of this spironeme are different from the "knospen" or buds of Meirowsky (12), Fig. 6, in that they appear regularly at the apex of each spiral turn and are delicate and pointed while the "knospen" occur irregularly on the end and laterally near the middle of the spirochetes, and are rounded. Meirowsky gives a good survey on these "knospen." They were considered by some to be a propagation phenomenon and by others a degeneration process. In Fig. 7 an example of the "knospen" is shown on a spironeme from the mouth of the cat seen in the course of this work, which is similar to No. 53 of Fig. 6, Meirowsky's sketches illustrating the "knospen."

As contrasted with the spironemes which were definitely of distinct morphological types, the treponeme group was made up of organisms of various sizes which seemed to grade into one another. The treponemes of the mouth varied in length from 5μ to 15μ , exceptionally 15μ to 20μ . Most of them averaged 5μ to 10μ , the greatest number being 5μ long. A few long individuals were evidently about to divide. The more numerous type (A) was 5μ long and 0.25μ thick, and the less frequent type (B) 10μ long and 0.25μ thick, that is, twice the length but the same diameter (Fig. 8). These measurements and the fact that incurvation forms (Fig. 9) were common among the longer individuals suggest that they constitute one species undergoing rapid transverse divisions. A few organisms were somewhat thicker (Fig. 10) and appeared to be a distinct species. The observations did not permit further conclusions as to the number of species represented by these forms. All the principal types of treponemes were found in the mouth.

Leptospiras were found in a few cases in mouth material. They were approximately 10μ long, very slender, and had extremely flexible hooked

ends. They were noted only occasionally, were few in number, very active, and not always easily detected in a field containing numerous spironemes and treponemes.

b. Esophagus: Though spirochetes of various types were found in great numbers in the mouth, none were observed in the esophagus, although in every animal scrapings emulsified in saline were carefully examined.

c. Stomach: In the gastric contents no spiral organisms were seen, but in the mucosa of 11 cats there was a rigid, coarse organism with closely-set spirals of uniform depth and with abruptly pointed ends. It was not encountered at any other site. In an emulsion of the pyloric mucosa of cat No. 4 a very delicate treponeme resembling *Treponema pallidum* was found. This treponeme appeared more delicate than treponemes A and B mentioned above, both under the dark-field and in fixed stained specimens.

d. Small intestine: The spirochetal flora of the small intestine was scanty. A few spironemes were seen in the duodenal contents of cat 46, the jejunal contents of cats 3, 46, and in the ileal contents of cats 5, 25, 46. Short treponemes, approximately 5μ long, with a spiral depth of 0.6μ to 1μ were found in the ileal contents of cats 13, 44. No spirochetes were observed in the mucosal scrapings of the small intestine.

e. Caecum and large intestine: Treponemes, spironemes, fusi-spirals, and leptospiras were found in the contents and scrapings of the caecum and large intestine. The first three types were found in larger numbers in the mucosal scrapings than in the contents. The spironemes and fusi-spirals were more numerous in the caecal scrapings and the short treponemes were more numerous in the colic scrapings. The majority of the spironemes and treponemes were morphologically similar to the two common forms in the mouth (Spironeme No. 1 and Treponeme A). The longer dividing forms of spironemes and treponemes were not as usual in the caecum and large intestine as in the mouth. Only one spironeme dividing was seen in the caecal scrapings of cat 29. The fusi-spiral was observed in the contents and scrapings of the caecum and large intestine, in greatest numbers in the caecal scrapings. In fixed stained specimens it was approximately 10μ long and 0.5μ thick in the middle, tapering gradually toward the sharply pointed ends (Fig. 11), and the spirals were usually irregular. Sometimes they were regular and shallow, one or two in number, with a depth of 2μ and an amplitude of 4μ . The movement of this organism is very characteristic. While rotating and advancing it exhibits the typical spiral form

as the reversed motion commences. Sometimes it assumes a circular form with loss of spirals. In our material we also observed, occasionally, the posterior end to become fixed and the anterior end to lash backward forming a circle (Fig. 11). After brief arrest the anterior end would spring forward and the spirals reform as the organism shot forward in the original direction.

As in the mouth, leptospiras were noted only a few times, being found in the mucosal scrapings of the caecum and large intestine of 5 cats. They were approximately 10μ long, very slender with very active hooked ends. They were seen only in small numbers under the dark-field and in fewer numbers in stained preparations.

Summary of the findings in adult cats according to types of organisms: Spirochetes and treponemes are the most common types throughout. The commonest spirochetes (No. 1) are approximately 10μ long and 0.5μ thick with 3 to 6 irregular spirals, the commonest treponemes (A) are approximately 5μ long, 0.25μ to 0.3μ thick, with 4 to 8 regular close-set spirals. The treponemes and spirochetes from the mouth, caecum, and large intestine were indistinguishable morphologically either under the dark-field or in fixed stained specimens. Fusi-spirals, leptospiras, and a coarse rigid spiral organism (stomach) are less common.

Summary of the findings in adult cats according to distribution in the animal body: In the mouth, spirochetes, treponemes, fusi-spirals, and leptospiras were found. The most common forms were the spirochetes (No. 1) and the treponemes (Type A). In the esophagus no spirochetes were noted. In the mucosal scrapings of the stomach, a few spiral organisms were observed. They were rigid, coarse, with closely-set spirals of uniform depth, and abruptly pointed ends. This type was not seen in any other part of the alimentary tract. In the pyloric wall of one cat a few treponemes (similar to *Treponema pallidum* and more delicate than Types A and B) were demonstrated. Rarely the contents of the small intestine showed a few spirochetes and a very few treponemes. Fusi-spirals, spirochetes, and treponemes were found in large numbers in both contents and scrapings of the caecum and large intestine. In none of the 84 cats examined were spirochetes found in the lungs, liver, spleen, heart, or kidney.

Kittens. The kittens studied ranged in age from mature embryos to approximately 90 days. In the 22 apparently normal kittens examined no spirochetes were found in the alimentary tract of those younger than 60 to 90 days. The type most often noted in older kittens was the spirochete, which was especially numerous in the mucosal scrapings of

the caecum of two kittens. Spirochetes were also found in the large intestine, more numerous in the mucosal scrapings than in the intestinal contents. Treponemes were found in a few cases in the scrapings of the large intestine, usually in moderate numbers but in one case they were very abundant. Treponemes were not observed in the contents of the large intestine. In none of the 22 apparently normal kittens were spirochetes noted in the liver, lungs, spleen, heart, or kidney.

B. Stained material

In staining the organisms, it was found relatively easy to stain both the spirochetes from the mouth and those from the caecum and large intestine by many different methods including Giemsa, Fontana-Tribondeau (20), Kliewe (9), Kliewe-Harris (6), Romanowsky (8), Medalia's modification of Wright's stain (11), diluted carbol fuchsin (16), Loeffler's methylene blue (18), gentian violet (19), Cross' stain (3), Benian's "relief stain" (1), and Burri's method (2). Spirochetes from cultures were somewhat more difficult to stain. Fontana-Tribondeau, Kliewe, and Kliewe-Harris were found most satisfactory and were used regularly. Various modifications of these stains were tried from time to time but no noticeable improvement over the original methods was observed.

In the examination of fixed stained material, only 2 types were recognized, the treponemes and spirochetes. The fusi-spirals appeared similar to the spirochetes when stained. They were usually S-shaped and contained one complete shallow spiral.

The treponemes and spirochetes found in the mouth, caecum, and large intestine were indistinguishable morphologically, either under the dark-field or in fixed stained specimens.

2. Filtration and cultivation experiments

A. Filtration

Fourteen out of 18 filtrations by gravity and all of the filtrations with pressure of 6 pounds yielded spirochetes. The gravity filtrations were centrifuged at low speed for 5 to 10 minutes, the supernatant fluid decanted and the few remaining drops used. The spirochete was the only type of spirochete seen in the filtrates. In several filtrations with the Berkefeld N candle the spirochetes alone came through, no bacteria appearing in the dark-field specimen. In the filtrations with the Berkefeld V under pressure a few bacteria were seen. When the filtrates were cultured as described below all contained bacterial contaminations. Filtered spirochetes were used in the cultivation experiments. When

filtrations were done with pressure the first few drops of the filtrate were used for cultivation and only after preliminary dark-field examination to exclude so far as possible the presence of bacteria.

B. Cultivation

Summarizing the results of approximately 600 tubes of fluid and semi-solid media inoculated with mouth, caecal, or intestinal material, 138 tubes were found upon examination to show greater or less increase of the spirochetes. All successful cultures were grown aerobically at 37°C. in media with a pH of 7.0.

Good growth of caecal and intestinal strains was obtained in Noguchi's diluted fluid medium (13) containing fresh cat liver and autoclaved rabbit liver, 3 successive subcultures being made from tubes of this type. The spirochetes were never obtained in pure cultures.

The mouth spirochetes did not multiply in this medium. A mixture of 5 cc. ascitic fluid and 5 cc. distilled water was found to give the greatest increase in number of mouth and intestinal spirochetes in the shortest time (approximately 2 days). Successful subcultures were also made in this medium. Hogue's ovomucoid medium (7) yielded growth of spirochetes from the mouth, caecum, and large intestine. Subcultures were also obtained in these cases. Noguchi's soft, semi-solid medium (14) was especially good for growing spirochetes from the mouth of the cat.

3. Implantation experiments in young cats per os and per rectum

Young cats 3 to 15 days old were used for the implantation experiments, because preliminary examination had shown that animals younger than 2 months did not have spirochetes in the mouth or gastrointestinal tract. Five groups of animals were used, lots of 3, 4, 3, 3, and 4 kittens constituting the 5 groups which were 13, 14, 15, 4, and 3 days old respectively when the experiments began.

Introduction of spirochetal material extended over a period of 2 weeks. The first 3 groups were fed the emulsified scrapings of the large intestine containing spirochetes of all types. The fourth group was fed the emulsified mucosal scrapings and diluted caecal contents of a hooded rat containing spirochetes morphologically similar to those found in the caecum and large intestine of the cat. In the fifth group half were given mouth spirochetes *per os* and half *per rectum*.

Summarizing the results, both mouth and intestinal types were implanted in the caecum after feeding *per os*. Mouth types were also

implanted in the caecum after introduction *per rectum*. A heavier implantation was secured when a preliminary dose of saturated solution of sodium sulfate had been administered. The mouth, liver, lung, heart, kidney, and spleen contained no spirochetes.

SUMMARY AND CONCLUSIONS

1. Forty-eight out of 50 normal adult cats contained spirochetes in the mouth or gastro-intestinal tract or both. Five out of 22 normal kittens, ranging in age from mature embryos to approximately 90 days, contained spirochetes in the caecum and large intestine. The animals containing these organisms were 70-90 days old.

2. The usual types of spirochetes observed were spironemes, treponemes, and fusi-spirals, present in large numbers in the alimentary tract. The first two types were abundant in the mouth, caecum, and large intestine. The fusi-spirals, while present in the mouth and large intestine, were most abundant in the caecum. Spironemes or treponemes or both were occasionally encountered in the duodenum, jejunum, or ileum. Spiral organisms with rigid, coarse, blunt spirals were found in a few stomachs. Leptospiras in relatively small numbers were also present at times in material from the mouth, caecum, and large intestine.

3. The most common type of spironeme in mouth or intestinal tract was approximately 10μ long and 0.5μ thick having 4 or more spirals about the same depth in the middle as at the ends with a depth of 0.6μ to 1.0μ and an amplitude of 1.0μ . A spironeme was also noted in material from the mouth of the cat which we regard as a new species and for which we suggest the name *Spironema langei*. It is a typical spironeme approximately 10μ long and 0.3μ to 0.5μ thick, with 3 to 6 spirals which were fairly constant when the organism was in motion and maintained their form in fixed preparations. The spiral depth and amplitude was 2μ . The ends were pointed and no terminal filaments were seen. A small projection occurred at the apex of each rounded spiral, clearly visible under the dark-field and in the films stained by the Kliewe-Harris method (Fig. 5). The fusi-spirals were 6μ to 10μ long, 0.5μ to 0.75μ thick in the center and tapering toward the ends which were sharply pointed. The organism when stained was S-shaped, usually contained one complete shallow spiral. The leptospiras were approximately 10μ long, very slender, with closely-set spirals and very flexible hooked ends. These types occurring in the mouth, caecum, and large intestine were morphologically indistinguishable.

4. The heart, lungs, liver, spleen, and kidney of 86 apparently normal cats and kittens did not contain spirochetes.

5. Cats younger than 2 months did not show spirochetes in the mouth or gastro-intestinal tract. Under natural conditions the spironeme was the first to appear in young cats.

6. All the organisms were satisfactorily stained. The Fontana, Kliewe, and Kliewe-Harris methods were the most satisfactory. Very delicate treponemes staining with more difficulty than *Treponema palidum* were well demonstrated by the Kliewe-Harris method.

7. Spironemes from the caecum and large intestine were filtered through Berkefeld N and V candles by gravity in 5 to 6 hours, and by a pressure of 6 pounds in 5 to 10 minutes. The filtrate from the Berkefeld N candles was apparently free from bacteria when examined under the dark-field.

8. Growth was obtained in various media though the spirochetes were never obtained in pure culture. Successful cultivation of spirochetes from the mouth, caecum, and large intestine through two subcultures was obtained in 5 cc. ascitic fluid diluted with an equal amount of distilled water, both raw and filtered material being used. Successful cultivation with 3 subcultures was also obtained with diluted ascitic fluid (1:3), containing a piece of autoclaved rabbit liver, and in Hogue's ovomucoid medium. They were successfully grown in Noguchi's fluid medium but did not grow in the diluted ascitic fluid with liver tissue. All successful cultures were incubated aerobically at 37°.

9. Spirochetes were successfully implanted in kittens 5 to 15 days old, mouth spirochetes of the adult cat being implanted *per os* and *per rectum* and those from the large intestine *per os*.

DEPARTMENT OF BIOLOGY,
QUEENS-CHICORA COLLEGE,
CHARLOTTE, N. C.

LITERATURE CITED

- (1) BENIAN. Brit. Med. Jour. **2**: 722. 1916.
- (2) BURRI. Das Tuscheverfahren, Jena, 1909.
- (3) CROSS. Bull. Johns Hopkins Hosp. **32**: 51. 1921.
- (4) DE MELLO AND FIALHO. Gior. di batteriol. e immunol. **3**: 689. 1928.
- (5) ESCHERICH. Centralbl. f. Bakt. **15**: 498. 1894.
- (6) HARRIS. Am. Jour. Hyg. **3**: 537. 1930.
- (7) HOGUE. Am. Jour. Trop. Med. **36**: 617. 1921.
- (8) JORDAN. General Bacteriology, p. 55. Saunders, 1928.
- (9) KLIEWE. Centralbl. Bakt., Ref., **76**: 232. 1924.
- (10) MACFIE. Ann. Trop. Med. **10**: 305. 1916.

- (11) MEDALIA. Jour. Am. Med. Assoc. **70**: 914. 1918.
- (12) MEIROWSKY. Med. Klin. **12**: 1181. 1916.
- (13) NOGUCHI. Jour. Exp. Med. **15**: 90. 1912.
- (14) ———. Jour. Exp. Med. **30**: 13. 1919.
- (15) ———. In Jordan and Falk, Newer Knowledge of Bacteriology and Immunology, p. 452. Univ. of Chicago Press, 1928.
- (16) SALOMON. Centralbl. f. Bakt. **19**: 433. 1896.
- (17) SANARELLI. Ann. d'igiene **37**: 125. 1927.
- (18) SMITH. Centralbl. f. Bakt. **16**: 324. 1894.
- (19) THOMPSON AND THOMPSON. Marcus Beck. Lab. Rept. **9**: 47. 1914.
- (20) TRIBONDEAU. Ann. de l'Inst. Pasteur **31**: 425. 1917.
- (21) ZUELZER. Handbuch der Pathogenen Protozoen **11**: 1670. 1925.

EXPLANATION OF PLATES

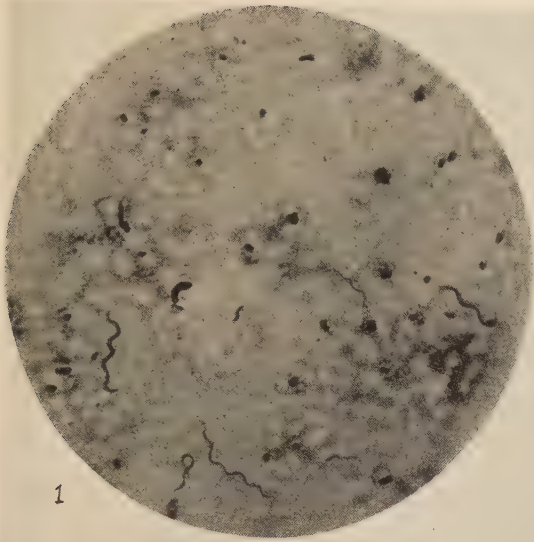
PLATE 21

- Fig. 1. Spironeme No. 1. Short and longer forms. Thicker forms, Spironeme No. 2, also present. Source, mouth. Photomicrograph $\times 900$.
- Fig. 2. Spironemes No. 1 and No. 2. Spironeme (lower right) in process of transverse division. Source, mouth. $\times 900$.
- Fig. 3. Spironeme No. 2. Short and longer forms. Spironemes No. 3 (center) faintly stained. Source, mouth. $\times 900$.
- Fig. 4. (a) Zuelzer's *Spirochaeta pseudorecurrentis*. Handbuch der Pathogenen Protozoen 11: 1670. 1925. $\times 900$.
(b) Spironeme No. 3. Spirochete from mouth of cat similar to Fig. 4a, in living material—spirals irregular when stained. $\times 900$.
- Fig. 5. Spironeme No. 4. *Spironema langei*, diagrammatic representation. Source, mouth.
- Fig. 6. Knospen. Meirowsky, Med. Klin. **12**: 1181. 1916. Photomicrograph. $\times 900$.

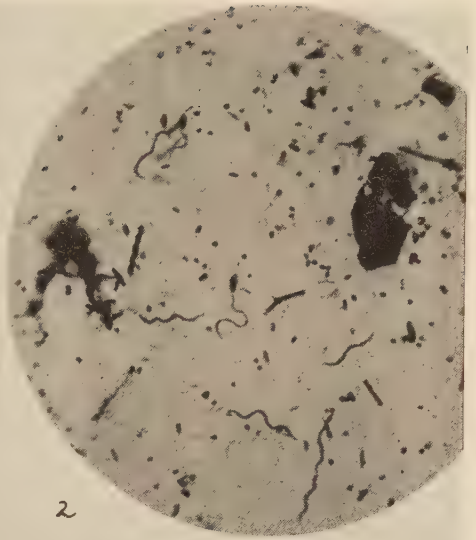
PLATE 22

(Photomicrographs $\times 900$)

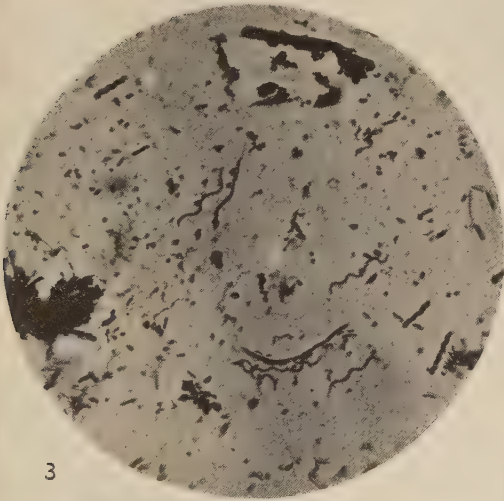
- Fig. 7. Knospen on Spironeme from mouth of cat, similar to No. 53 of Fig. 6.
- Fig. 8. Treponemes A and B, short and longer forms. Source, mouth. Spironeme No. 1.
- Fig. 9. Treponemes A and B. Thicker forms of treponemes showing incurvation.
- Fig. 10. Thicker forms of treponemes.
- Fig. 11. Fusi-spirals.



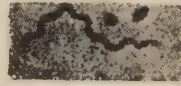
1



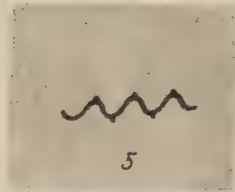
2



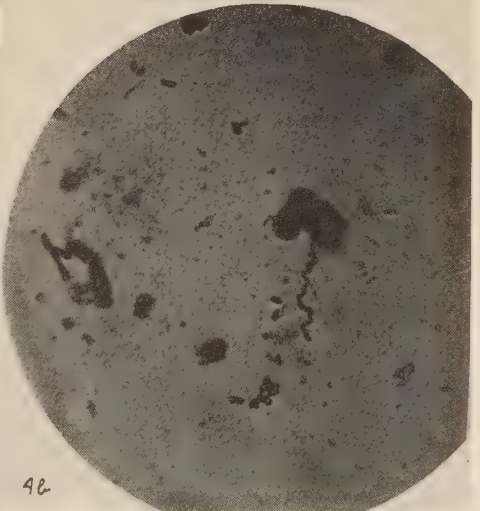
3



4a



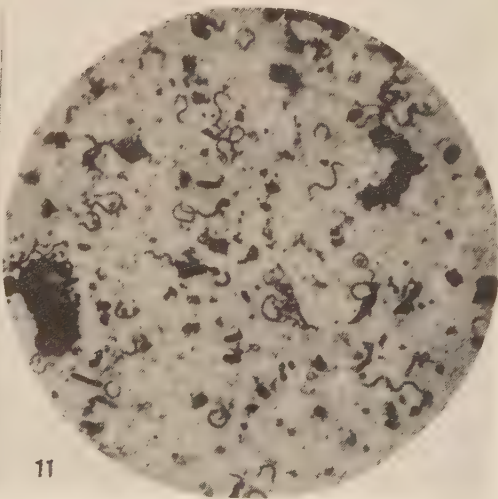
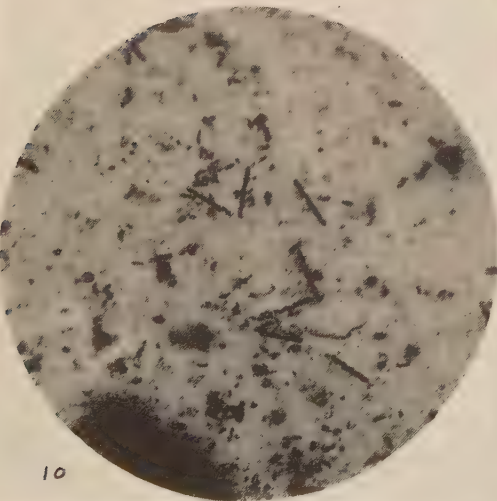
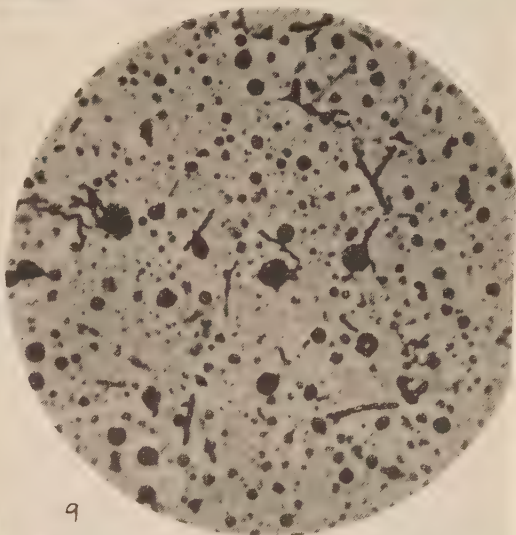
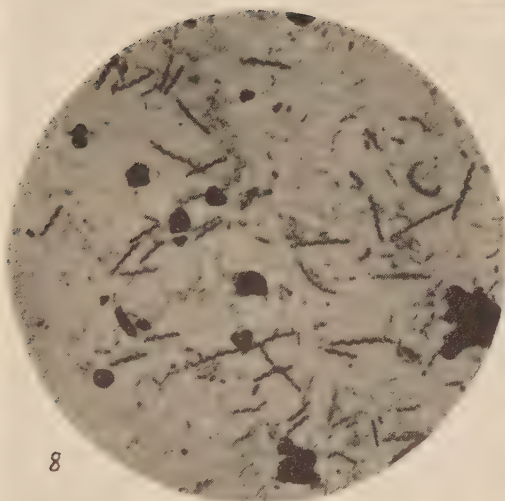
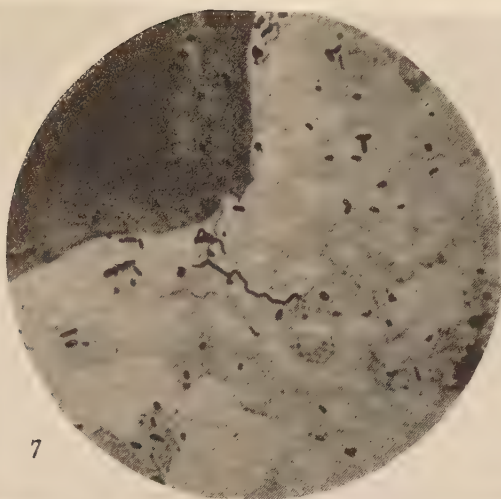
5



4b

Plate 21. Nematodes of the genus *Pollia*. Figures 1-59 show the general appearance of the nematodes. Figures 60-69 show the structure of the head and tail. Figures 70-79 show the structure of the body. Figures 80-89 show the structure of the tail. Figures 90-99 show the structure of the head and tail.

<i>Pollia</i> Group eggs, head, tail	<i>Robinson</i> Group eggs, head, tail	<i>Robinson</i> Group eggs, head, tail	<i>Robinson</i> Group eggs, head, tail	<i>Pollia</i> Group eggs, head, tail	<i>Pollia</i> Group eggs, head, tail
1 5 7	6 14 9	10 11 12 13	14 15 16 17	18 19	20 21 22
23 24	25 26	27 28 29	30 31 32	33 34 35	36 37 38
39 40	41 42 43	44		45 46 47	48 49 50
51 52	53 54 55	56		57 58 59	60 61 62
63 64	65 66 67	68		69 70 71	72 73 74
75 76	77 78 79	80		81 82 83	84 85 86
87 88	89 90 91	92		93 94 95	96 97 98
99					



VITA

Early Education: Eloise Elaine Greene, born in Bainbridge, Georgia, April 14, 1903. Attended Bainbridge City Schools. Graduated Bainbridge High School, Classical Diploma, June 1920.

College Training: Georgia State College, Milledgeville, Georgia, 1920-24. B. S. 1924. Peabody College, Nashville, Tenn., M.A. 1928. Johns Hopkins University, Baltimore, Md. 1929-31, Ph.D. 1931. Special work in Biology at Emory University, Atlanta, Georgia; University of North Carolina, Chapel Hill, N. Car.; Northwestern University, Chicago, Ill. University of Chicago, Chicago, Ill.

Professional: Student assistant, Biology, Georgia State College for Women, 1922-24. Head of Science Department, Central High School, Rutherfordton, N. Car., 1924-27. Instructor of Biology and Health, Joe Brown High School, Atlanta, Ga., 1927-28. Associate Professor of Health, Georgia State College for Women, Milledgeville, Ga., 1928-29. Scholarship to Johns Hopkins. Head of Biology Department, Queens-Chicora College, 1931-34.

